This document includes Section 7.0 – WHEC 378 Class: High Endurance Cutters that Process Bilgewater and Dirty Ballast, of the Draft EPA Report "Surface Vessel Bilgewater/Oil Water Separator Characterization Analysis Report" published in August 2003. The reference number is: EPA-842-D-06-017

DRAFT
Characterization Analysis Report
Surface Vessel Bilgewater/Oil Water Separator

Section 7.0 – WHEC 378 Class: High Endurance Cutters that Process Bilgewater and Dirty Ballast

August 2003

SECTION 7.0 – WHEC 378 CLASS

TABLE OF CONTENTS

LIST OF TABLES

7.0 WHEC 378 CLASS

The USCG HAMILTON Class 378' High Endurance Cutter (WHEC 378) was selected to represent the group of CI Ships that Process Bilgewater and Dirty Ballast. The WHEC 378 vessel group consists of 29 coast guard cutters. The WHEC 378 class has the second largest vessel displacement and number of hulls within the group. This group has no vessels under construction. This chapter presents the physical parameters, chemical data, field data, descriptive information, and generation rates for the WHEC 378 Class vessels.

On USCGC MORGANTHAU, bilgewater is collected and pumped to an oily waste holding tank (OWHT). While underway the bilges are pumped to the OWHT every few days or when the bilgewater level rises to three or four inches. Once in the OWHT, bilgewater is processed by the ship's oil water separator (OWS). This group processes dirty ballast water through the same oil water separator (OWS) used to process bilgewater. Therefore, they are equipped with OWS four to ten times larger than comparably sized vessels that only process bilgewater. Sampling was conducted in-port and underway aboard one of the ships in this group, USCGC MORGENTHAU (WHEC 722) from August 30, 1999 through September 7, 1999 and from November 13-19, 1999.

The primary bilgewater OWS system currently installed onboard WHEC 378 Class vessels includes one single stage 44-gpm gravity coalescence type oil-water separator. Upstream of the OWS is a duplex type strainer functioning to remove large particulate matter from the wastestream. These vessels typically process bilgewater both pierside and underway, discharging the processed effluent into the surrounding waters. The processing needs of the ship within 12 nm are met through the use of one 44-gpm system; therefore subsequent characterization analyses are based on a 44-gpm system processing the entire volume of untreated bilgewater.

The following summarizes the general vessel characteristics for the WHEC 378 Class vessels.

<u>General Vessel Characteristics (USCG, 2002)</u>

Draft (ft):	15
Length at waterline (ft):	378
Beam at waterline (ft):	43
Displacement (tons):	3,250

7.1 BASELINE DISCHARGE

The baseline discharge is defined as the direct discharge of the bilgewater collected in the OWHT. This discharge is assumed to occur, at the normal OWS flow rate while bypassing the OWS. It is important to note that, although the term baseline discharge is used for this report, the Armed Forces do not discharge bilgewater from the OWHT directly overboard without treatment. This scenario is included in the analysis only to establish a reference point for subsequent comparisons. The baseline analysis will be based on discharging the entire volume of untreated bilgewater at 44 gpm through a single OWS system discharge port.

7.1.1 Characterization Data

Sources of bilgewater aboard the WHEC 378 Class vessels include: condensate, which forms on the interior hull and piping; evaporator distillate dump; machinery steam and condensate drains; leaking propeller shafts, pump and packing glands; and leaking piping, valves, and flanges. The liquid phase of this fluid may contain oily constituents including DFM (emergency diesel generators), JP-5 fuel (main gas turbine engines and aircraft), 2190TEP lube oil (auxiliary equipment), 9250 lube oil (emergency diesel generators), synthetic lube oil (main engines and aircraft engines), hydraulic oil (elevators, cranes, and winches), and various grades of grease lubricants used on pulleys, cables, valves, and other components which may have dripped directly into the bilge spaces, or other ship spaces communicating with the bilge . Other potential bilge constituents include dissolved metals and metal-containing particulate matter

7.1.1.1 Physical Parameters

The physical parameters presented in this section include values necessary for hydrodynamic modeling of the discharge, which differs from shipboard data. The characteristics of the WHEC 378 baseline discharge (Table 7-1) were developed using assumption that bilgewater is discharged overboard at the OWS design flow rate(s) while bypassing the OWS.

Table 7-1. Discharge Characteristics for WHEC 378 Baseline

Modeling Parameters	Values
Vertical (feet)	+1
Transverse (feet)	-21
Length (feet)	209
Diameter (inches)	2
Temperature (°C)	25
Salinity (ppt)	25
Flow (gpm)	44
Velocity (ft/sec)	4.5
Duration of Release Event (hr)	0.93
Time Between Release Events (hr)	2617.1

Vertical – Approximate distance from waterline to discharge port (+, above, -, below)
Transverse – Distance from centerline to discharge port (+, port, -, starboard)
Length – Approximate distance from forward perpendicular to discharge port
Diameter – Diameter of discharge port
ppt – parts per thousand
gpm – gallons per minute
ft/sec – feet per second
hr – hour
°C – degree Celsius

The influent of the OWS is characterized in this report as the baseline from which a relative analysis of the marine pollution control device (MPCD) options can be performed. The parameters for the engineering and modeling recommendation summary are based on the specifications in WHEC 378 installation drawings of the OWS and a ship check.

Several parameters were identified for the discharge port on the WHEC 378. These parameters include: discharge port location in relation to the waterline (vertical), distance from the centerline to discharge port (transverse), approximate distance from forward perpendicular to discharge port (length), and discharge port diameter (diameter) (USCG, 1987). Additional discharge characteristics identified for modeling purposes include temperature, salinity, flow rate, discharge velocity, duration of release event, and time between release events.

The temperature of bilgewater is dependent on several factors. Bilgewater on a WHEC 378 Class vessel is temporarily held in the ship's bilge or in an OWHT. Consequently, ambient air temperature inside the machinery space and the temperature of the source bilgewater can have an effect on bilgewater temperature. However, because the bilge and OWHT are separated from the waterbody only by the ship's hull, bilgewater is often at or near the ambient water temperature. Because bilgewater is not used as a cooling or heating fluid and there is ample opportunity for thermal equilibration (heat transfer through the metal hull), bilgewater is assumed to be at the temperature of the receiving water. Further, for modeling purposes, the ambient water temperature is assumed to be 25º C.

Unlike other physical parameters used for modeling purposes, sampling data from the OWS influent were used to determine the salinity value for WHEC 378 baseline discharge (Navy, 2000e). To facilitate obtaining a representative salinity value, an average of the sample results was used to determine one representative salinity value for the baseline discharge (the same value is used for subsequent analysis of the primary treatment MPCD; see Section 7.2.1.1).

Of the remaining discharge characteristics required for modeling, flow, velocity, and duration of release event are interdependent. The exit velocity out of the discharge port is equal to flow rate divided by the cross-sectional area of the discharge pipe (velocity = flow/area). The flow rate for the baseline is the rated capacity of the MPCD (i.e., 44 gpm for the gravity coalescer). The area is calculated from the diameter of the discharge pipe. The duration of the release event is based on the size of the OWHT, the rated capacity of any control in place, and the bilgewater generation rate. The volume of bilgewater processed is based upon Coast Guard practices, which assumes processing begins when the OWHT reaches 70 percent capacity. The duration is calculated as follows:

Duration of Release = (0.70 * OWHT Volume) / (Rated MPCD Capacity – Bilgewater Generation Rate)

The time between release events is determined using bilgewater generation rate data and OWHT capacities. Again, for purposes of modeling, it is assumed that the entire discharge release/non-release cycle (a release event followed by the time between release events) occurs while the vessel is pierside. The formulas used to determine some of the values in the physical parameters section are presented in Appendix A.

7.1.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

During Uniform National Discharge Standards (UNDS) Phase II, sampling was conducted aboard one vessel of the WHEC 378 Class, USCGC MORGENTHAU (WHEC 722) from 30

August 1999 to 7 September 1999 and 13-19 November 1999. These sampling episodes serve as the primary source of chemical data for this vessel group. Two bilgewater/ OWS discharge samples were collected during each of the underway periods.

The samples were analyzed by Ecology and Environment, Inc., Pacific Analytical, Inc., and Q Biochem (formally ETS Analytical Services, Inc.). The results were reviewed by EPA and DoD to determine the quality of the analytical data. However, some sample data were excluded in the final calculations as documented in the *Draft Sampling Episode Report–USCGC MORGENTHAU* (Navy, 2000e), based on Sample Control Center (SCC) review. Data quality was considered for all analyses conducted. To ensure data quality after reviewing documented matrix spike failures, and process information discrepancies, a confirmation analysis was conducted for pesticides. The confirmation analysis revealed that there were no pesticides present in the reanalyzed samples. As a result, pesticides are not included in bilgewater discharge profiles (Navy and EPA, 2002).

SCC validated data include the constituents present in the waste stream and their concentrations. Sampling was conducted on the OWS influent, which was considered the untreated baseline for this vessel group. Several methods used for analyses during Phase I are different than those used for Phase II analyses. For example, mercury was analyzed by EPA Method 1631 for Phase I, but for Phase II samples, EPA Method 1620 was used. The primary difference between these methods is that Method 1631 has a much lower detection limit than Method 1620. The decision to use Method 1620 in place of Method 1631 was due to the susceptibility of Method 1631 to a variety of matrix interferences stemming from liquids released from machinery room equipment. After reviewing Phase I analytical data, EPA Method 1620, with the higher detection level, was found to be sufficient for Phase II because constituents were found in sufficiently high concentrations that the cost of using more sensitive and expensive techniques was unjustified. The sampling and analytical decisions made for samples collected on WHEC 378 are detailed in the Sampling and Analysis Plan (SAP). Four field samples were taken during each sampling episode from the influent (representing the baseline) to the OWS. For more information, see the *Sampling Episode Report –USCGC MORGENTHAU (WHEC 378)* (Navy, 2000).

Constituent concentrations are represented as the geometric mean of the measured concentrations in the influent samples. See Appendix F for final constituent values.

Field Information

Field data refers to information obtained at the time of sample collection. The field tests conducted on WHEC 722 included pH, temperature, salinity, specific conductance, and free and total chlorine. The averages of all field measurements is reported in Table 7-2.

Table 7-2. Field Testing Parameters for WHEC 378 Baseline

Field Parameter	Values
pH	7.1
Temperature	17 °C
Salinity	3.4 ppt
Specific Conductance	6200 µS/cm
Free Chlorine	0.32 mg/L
Total Chlorine	0.33 mg/L

Descriptive Information

Descriptive information refers to data collected to facilitate the environmental effects analysis and is presented here to give a more complete description of the discharge. This information included observations or measurements of color, floating materials, odor, settleable materials, and turbidity/colloidal matter. For the parameters where the results were based on field tests, an average was used as the parameter value except in cases where total dissolved gases was measured. For this parameter, the lowest dissolved oxygen (DO) value was reported in the profile report and used in the environmental effects analysis, because lower DO values are a greater environmental concern. Floating material, foam, scum, settleable materials and total dissolved gases were not specifically observed for the WHEC 378 Vessel class. Table 7-3 lists values for the descriptive data.

Table 7-3. Descriptive Discharge Profile for WHEC 378 Baseline

Narrative Parameter	Field Observations
Color	Cloudy, dark yellow
Floating Materials	None specifically observed in samples collected
Foam	None specifically observed in samples collected
Odor	Slight fuel/oil smell
Scum	None specifically observed in samples collected
Settleable Materials	None specifically observed in samples collected
Total Dissolved Gases	Not measured in samples collected
Turbidity/Colloidal Matter	Cloudy

7.1.1.3 Discharge Generation Rates for Mass Loading

Vessels in the WHEC 378 vessel group are stationed in saltwater ports and do not operate in freshwater. Daily generation rates were obtained from previously reported underway surveys (Navy, 1997a and 1995), which assume that in port generation rates are approximately 25 percent of the underway generation rates. The annual discharge volumes are derived in Table 7-4 by multiplying these reported values by the average number of days that the class spends in port or at sea.

Table 7-4. WHEC 378 Vessel Group Generation Volumes

Class	Number of Vessels	Days in Port[1]	Days Underway (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (gal/day)			Annual generation rate per class (gal/year)		
					In port	Underway (0-12 nm)	Underway (12+ nm)	In port	Underway (0-12 nm)	Underway (12+ nm)
WAGB 399	2	121	101	115	2.5E+02	9.8E+02	9.8E+02	6.1E+04	2.0E+05	2.3E+05
WHEC 378	12	116	26	209	3.8E+01	1.5E+02	1.5E+02	5.3E+04	4.7E+04	3.8E+05
WMEC 210	16	176	12	162	3.1E+01	1.3E+02	1.3E+02	8.7E+04	2.4E+04	3.2E+05
Total	30	-	-	-	3.2E+02	1.3E+03	1.3E+03	2.0E+05	2.7E+05	9.4E+05

[1] Total number of days for in port, Underway 0-12nm, and Underway 12+nm may not add up to 365 days due to some vessel classes being removed from the water to facilitate cleaning, maintenance, and/or repair.

7.2 PRIMARY TREATMENT

Gravity coalescer represents the currently installed primary treatment MPCD onboard WHEC 378 Class vessels. Most ships of the WHEC 378 Class currently have one 44-gpm system with a single discharge location. Therefore, subsequent analyses are based on a single 44-gpm system processing the entire volume of bilgewater. Primary treatment creates two waste streams: the aqueous fraction, which is discharged overboard, and the oil fraction, which is directed to the onboard waste oil holding tank. The characterization of the aqueous fraction is described below. The oil fraction is subject to collection, holding and transfer (CHT), treated at a properly permitted facility, and applicable Federal, State, and local disposal regulations.

7.2.1 Characterization Data

Characterization data are comprised of physical parameters, chemical data, field data, and descriptive information. Each of these parameters is discussed below. See Section 7.1.1 for identification of possible bilgewater sources.

7.2.1.1 Physical Parameters

The physical parameters include values used for hydrodynamic modeling of the discharge, which differs from ship board data. The characteristics for the WHEC 378 baseline discharge, as detailed in Section 7.1.1.1, are not affected by the addition of a primary MPCD. Table 7-5 summarizes the parameters used for modeling purposes.

Table 7-5. Discharge Characteristics for WHEC 378 Primary Treatment

Modeling Parameters	Value
Option Group	Primary Treatment
Vertical (ft)	+1
Transverse (ft)	-21
Length (ft)	209
Diameter (in)	2
Temperature (°C)	25
Salinity (ppt)	25
Flow (gpm)	44
Velocity (ft/sec)	4.5
Duration of Release Event (hr)	0.93
Time Between Release Events (hr)	2617.1

Vertical – Approximate distance from waterline to discharge port (+, above, -, below)
Transverse – Distance from centerline to discharge port (+, port, -, starboard)
Length – Approximate distance from forward perpendicular to discharge port
Diameter – Diameter of discharge port
ppt – parts per thousand
gpm – gallons per minute
ft/sec – feet per second
hr – hour
°C – degree Celsius

The formulas used to determine some of the values in the physical parameters section are presented in Appendix A.

7.2.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

During Phase II of UNDS, sampling was conducted while underway on one WHEC 378 Class vessel, USCGC MORGENTHAU (WHEC 722), and serves as the primary source of chemical data for this vessel group. The samples from this ship were taken prior to and following the gravity coalescer. Based on the samples collected following the gravity coalescer, a final concentration was determined for each constituent. However, some sample data were excluded in the final calculations as documented in the *Draft Sampling Episode Report–USCGC MORGENTHAU* (Navy, 2000e), based on SCC review. See Appendix F for final constituent values.

Field Information

Field information refers to data obtained at the time of sample collection. Field tests conducted on the gravity coalescer samples from WHEC 722 included pH, temperature, salinity, specific conductance, and free and total chlorine. The averages of all field measurements in reported in Table 7-6.

Table 7-6. Field Testing for WHEC 378 Primary Treatment

Field Parameter	Values
pH	6.9
Temperature	17 °C
Salinity	4.9 ppt
Specific Conductance	8700 µS/cm
Free Chlorine	0.56 mg/L
Total Chlorine	0.50 mg/L

Descriptive Information

Descriptive observations and tests were conducted on MPCD gravity coalescer samples from the WHEC 722. This information included observations and measurements of color, floating material, odor, settleable material, and turbidity/colloidal matter. For the parameters where the results were based on field tests, an average was used as the parameter value except in cases where total dissolved gases was measured. For this parameter, the lowest DO value was reported in the profile report and used in the environmental effects analysis, because lower DO values are a greater environmental concern. Floating materials, foam, scum, settleable materials, and total dissolved gases were not specifically observed for the samples collected. Table 7-7 lists values for the descriptive data.

Table 7-7. Descriptive Discharge Profile for WHEC 378 Primary Treatment

Narrative Parameter	Field Observations
Color	Cloudy, yellow
Floating Materials	None specifically observed in samples collected
Foam	None specifically observed in samples collected
Odor	Slight fuel/oil smell
Scum	None specifically observed in samples collected
Settleable Materials	None specifically observed in samples collected
Total Dissolved Gases	Not measured in samples collected
Turbidity/Colloidal Matter	Not measured in samples collected

7.2.1.3 Discharge Generation Rates for Mass Loading

The use of a primary treatment MPCD does not affect the generation rate of bilgewater; therefore, the baseline generation and annual volume data are used for the annual discharge volume for this MPCD treatment system. It is assumed that the volume change due to the removal of oil by the treatment device is negligible. See Table 7-4, Section 7.1.1.3, for the baseline generation volumes.

7.3 Collection, Holding, and Transfer within 12NM

CHT is the onboard collection, containment, and subsequent transfer of bilgewater to shore facilities or ship waste offload barges (SWOBs). CHT does not involve any treatment of raw bilgewater on board the generating vessel. CHT may require the installation of some shipboard equipment, such as piping or tanks, to provide additional holding capacity. This MPCD option results in no (zero) liquid discharge to surrounding waters within 12 nm.

7.3.1 Characterization Data

Characterization data are comprised of physical parameters, chemical data, field data, and descriptive information. Each of these parameters is discussed below. See Section 7.1.1 for identification of bilgewater sources. However, because this MPCD option results in no (zero) liquid discharge to surrounding waters within 12 nm, there are no characterization data to address.

7.3.1.1 Physical Parameters

This MPCD option results in no (zero) liquid discharge to surrounding waters within 12 nm; therefore, there are no discharge characteristics to consider.

7.3.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

Because a waste stream is not directly discharged to surrounding waters within 12 nm for this MPCD option, there are no constituents to consider.

Field Data

Because a waste stream is not directly discharged to surrounding waters within 12 nm for this MPCD option, there are no field data to consider.

Descriptive Information

Because a waste stream is not directly discharged to surrounding waters for this MPCD option, there are no descriptive information data to consider.

7.3.1.3 Discharge Generation Rates for Mass Loading

CHT results in no (zero) liquid discharge to surrounding waters within 12 nm. Therefore, the annual discharge volume is zero.

7.4 UNCERTAINTY AND DATA QUALITY FOR WHEC 378 DISCHARGE

The sources and levels of uncertainty in bilgewater characterization data vary by discharge parameter. This subsection describes the uncertainty associated with physical parameters; constituent data, classical data, and other descriptors; and discharge generation rates.

7.4.1 Physical Parameters Uncertainty and Data Quality for WHEC 378 Discharge

Schematic Data

The information provided for the physical parameters of WHEC 378 discharge is based on process knowledge and the vessel specifications of the representative vessel. Certain physical parameter values used in this report, including representative vessel length, discharge port diameter, and distance from centerline to discharge port (transverse), are taken directly from vessel schematics. These parametric values do not vary among vessels in the class. Certain other parameters vary with load conditions. These condition-specific parameters include approximate distance from waterline to discharge port (vertical) and discharge method. The discharge was assumed to occur under full load conditions to facilitate a comparison of baseline and MPCD option performance. This assumption is supported by Armed Forces expert knowledge of ship status, which indicated that when vessels are pierside they typically are loaded for deployment.

Modeling Data

One use of the discharge characterization information is to provide input data for hydrodynamic modeling of a discharge plume within a mixing zone. Modeling is performed to determine plume dilution factors at the edge of a mixing zone. Modeling calculations involve various parameters that include discharge temperature, density (salinity), and vessel attributes related to bilgewater discharge, such as the distance from the discharge port to the waterline. The bilgewater temperature was assumed to be equal to ambient water temperature for modeling purposes. Bilgewater is stored in OWHTs in direct contact with the hull, resulting in temperature equilibration. The bilgewater salinity data was taken from UNDS sampling results. Uncertainty related to sampling is discussed in Section 7.4.2 and applies to the salinity data.

As stated in Section 7.1.1.1, the discharge flow rate used to characterize the discharge is based on the rated capacity of the processor as reported by the manufacturer. The duration of, and time between release events are closely related and are dependent on the volume of the OWHT. The volume of the OWHT at processing onset determines the duration of the release event. Likewise, the time between release events is related to the capacity of the OWHT and the bilgewater generation rate. A simplifying assumption, that the discharge of bilgewater occurs when the OWHT reaches 70 percent of capacity, was based on knowledge derived from equipment experts.

7.4.2 Constituent Data, Classical Data, and Other Descriptors Uncertainty and Data Quality for WHEC 378 Discharge

Sampling was conducted aboard the WHEC 722 according to the SAP (Navy, 2000e). Deviations in sampling practices, analytic testing, laboratory equipment, processing equipment, and specimen handling exist and may affect the results. For more information on the sampling plan, see the WHEC 722 SAP.

During the sampling episode, deviations from the sampling plan were noted in the Sampling Episode Report (SER).

- The isokinetic flow rates fluctuated during sample collection on day one. Due to fluctuations in flow rate the necessary sample volume could not be collected. As a result, there was insufficient influent sample volume, from grab 1, collected to perform analyses for biochemical oxygen demand (BOD), total dissolved solids (TDS), total suspended solids (TSS), volatile residue, alkalinity, sulfate, chloride, pyrethrins, pesticides and herbicides. Additionally, the second influent oil and grease (HEM)/total petroleum hydrocarbons (TPH) sample was taken after the effluent sampling occurred.
- For the first two samples collected on 31 August and 7 September the appearance of the effluent was darker and cloudier than the influent samples. Subsequent laboratory analyses showed that the oil concentration for the OWS effluent exceeded the 15-ppm oil content monitor (OCM) set point.
- For the second two samples collected on the 13 November and 17 November the OWS effluent color and clarity appeared similar to the influent samples. Subsequent laboratory analyses showed that the oil concentration for the OWS effluent exceeded the 15-ppm OCM set point.
- The OWS installed operates with a counter-current water/oil flow path. Naval Surface Warfare Center Carderock Division - Ship System Engineering Station (NSWCCD - SSES) experience has shown that other OWS models with this design have been ineffective in oily waste treatment (Navy, 2000e).

The SER also details issues identified during the sample analysis, including the SCC's review of the analytical data. The reports also contain further details regarding any additional data qualifiers for specific constituents for the samples. A complete description of how qualified data were used in the UNDS program can be found in Section 7.1.1.2.

WHEC 722 sample data were used to characterize this vessel group. As described in the *Vessel Grouping Representative Vessel Selection for Surface Vessel Bilgewater/Oil Water Separator Discharge* (Navy and EPA, 2001a), although subsequent decision making resulted in the selection of WHEC 378 to represent this vessel group, process knowledge indicates that there should be no significant differences in bilgewater composition between vessels of the same class.

7.4.3 Discharge Generation Uncertainty and Data Quality for WHEC 378 Discharge

Bilgewater generation rates for the WHEC 378 vessel group used in this report to characterize the discharge are estimated based on process knowledge and previously reported values. The UNDS Phase I Surface Vessel Bilgewater/OWS Nature of Discharge Report (NOD) estimates that the average in-port generation rate for a WHEC Class Vessel is approximately 2,000 gal/day (EPA and DoD, 1999). However, based on actual performance data, the generation rate is 38gal/day in port and 150 gal/day underway (Navy, 1997a). Additionally, the three vessel classes that comprise this vessel group vary in vessel size, machinery, and displacement. Vessel engine and auxiliary machinery rooms are the main sources of bilgewater (EPA and DoD, 1999) therefore unlike other discharges, the bilgewater generation rates do not depend on crew size. As a result, having multiple vessel classes in the group results in more variation in generation rates and adds the uncertainty to these values.

The addition of a primary treatment MPCD does not affect the annual generation rates for mass loading. As a result, the uncertainty identified here applies to all MPCD options.